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# Cometary Atmospheres:
# Modeling the Spatial Distribution of Observed Neutral Radicals

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16. Abstract


The Monte Carlo particle-trajectory model for the spatial distribution of cometary radicals has been modified to include the heliocentric distance dependence of the parent molecule velocity, and the heliocentric velocity dependence for CN fluorescence and radiation pressure. The study of available data on the observed spatial distributions of cometary radicals has begun and a preliminary comparison of some newly published data with previous studies is discussed.



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I. Program of Research for the First Quarter

Research activities during this first quarter have involved (1) several refinements and modifications to the computer code for the Monte Carlo particle trajectory model, and (2) preliminary comparison of recently published radical parent Haser scale length data with previously published data.

1. Model Updates

Whipple (1980) has shown that the outflow velocity of parent molecules is a slowly decreasing function of heliocentric distance. Delsemme (1982) has derived a semi-empirical law for this dependence to be $V = .58\ r_H^{-1/2}$, where V is in km/s and $r_H$ is in astronomical units. This velocity dependence is now automatically incorporated into the computer code for the Monte Carlo model. It has been common practice to assume an $r_H^2$ law for the parent molecule scale lengths in Haser's model. Observational evidence, on the other hand, suggests that a value for the exponent somewhat less than 2 may be more appropriate (Combi and Delsemme 1980), as would be expected from the above velocity dependence combined with an $r_H^2$ dependence from photochemical lifetimes.

Tatum and Gillespie (1977) calculated the dependence on heliocentric velocity of the resonance fluorescence emission rate for the CN(0-0) violet bands at 3883 Å. The velocity dependence results from the variable (with Doppler shift) overlap of rotational lines of cometary CN with absorption lines in the solar spectrum, some of which are from the same CN band. Their variable emission rate data has been directly incorporated in the model since it affects both the observed emission rate as well as the radiation pressure acceleration.

In addition to these changes to the physics of the model, a computer code shell has been constructed around the model so as to enable the direct calculation of radical production rates from observed photometric band emission fluxes.

2. New Haser Scale Lengths

Newburn and Spinrad (1984) have recently published the results of spectrophotometry of 17 comets. In particular, they presented Haser scale lengths for the parent modelcules of $C_2$, $C_3$ and CN for 5 of these comets.

A preliminary comparison of their data for CN with previously published CN scale lengths (Combi and Delsemme 1980; Delsemme and Combi 1983) is quite interesting. Their data covers a range of heliocentric distances from .78 to 1.69 AU which is quite complementary to our data which covered from .44 to 1.21 AU. Considering the large amount of scatter in this type of analysis, the two data sets seem to merge reasonably well with no gross systematic differences. However, comparison of their $C_2$ parent scale lengths with both previously published as well as our as yet unpublished values does show some apparent systematic differences. Since both the types of analyses as well as the two populations of comets studied were quite different, a more careful comparison of these two data sets is needed.

## II. Program of Research for the Next Quarter

Research activities during the next quarter will concentrate on (1) incorporation of the OH heliocentric velocity dependent lifetime and emission rate in the model, (2) continued study of available data on the spatial distributions of cometary radicals, and (3) a preliminary evaluation of the effect of radiation pressure on photometrically determined production rates.

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